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Research Article

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Nutrient use efficiency and crop productivity of rice as influenced by dates of planting and nutrient management practices

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Summary

The nutrient uptake studies were also influenced nutrient management practices and nutrients availability. The major and micronutrient content in grain and straw was also influenced significantly due to application of organics and fertilizers. The higher nutrient contents and their uptake was recorded T_5 (100%NPK+Zn+S+GM @6 t/ha+ FYM @3 t/ha +straw@3 t/ha as mulch +1% Fe + 0.2% B spray) and T_4(150%NPK+Zn+S+1%Fe+0.2% B spray) treatments.

Key words : Nutrient content, Nutrient uptake, Different dates of planting, Rice

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Introduction

The estimation of nutrient content in soil profiles will provide the information regarding the status and nature of removal or uptake pattern of different nutrients by the growing plants root as well as the nature of the movements of various nutrients within the soil profile. Many factors are responsible for increasing yield and quality of crop. Among these proper and balanced application of fertilizers is one of the most important factor contributing towards higher productivity, and good health of the soil (Ahmad *et al.*,1994). The organic manures improve the soil health and thereby enhance the crop yield per unit of applied nutrient (Meelu and Morries, 1984). Application of organic manures along with rock phosphate helps in its dissolution and increases the availability of P. Integrated use of organic manures and inorganic fertilizers can contribute to increase in the N content of rice soil as well as to increase in long term productivity. Nitogen supply can influence grain yield by increasing the number of spikelets, panicle, grain weight and panicle length (Gupta and O' Tool, 1986). As N supply increases there is an increase in the proportion of total dry matter distributed to the grain. Surface area of contact with soil particles, which may help in retarding the P-fixation, and consequently increase the availability of P throughout the growth period of crop. Increase in avalilability of phosphorus in soil as well as its concentration and uptake in rice plant as influenced by single super phosphate (SSP) blended with cow dung has been established.

Thakur (1993); Channabasavanna and Setty (1994) and Panda *et al.* (1995) reported that increased dry matter production including grain yield of rice was due to increased N and P uptake in response to external supply of both N and P fertilizers. Ali *et al.* (2005)

reported that among the different methods and time of potash application treatment, maximum paddy yield was obtained from the treatment where whole of potash was broadcasted at 25 DAT, which is due to efficient potash uptake, increase grain yield, better growth and development.

Resource and Research Methods

The field experiment was conducted at the research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *Kharif* 2012-2013. Raipur comes under agro-climatic plain zone of Chhattisgarh state and lies at $21^0 16^{'}$ N latitude and $81^0 26'$ East longitude with an altitude of 289.56 m above, respectively the mean sea level. The soil was clay loam having 184.50, 18.33, 339.62 available N, P, K, respectively with pH 7.6. The experiment were laid out in twenty one treatment combinations involving three dates of crop establishment (early, optimum and late sowing) as main plot with seven sub treatments related to nutrient management were tried in Split Plot Design with four replications. Nitrogen content in plant sample was determined by using micro-Kjeldahl method as described by Chapman and Pratt (1961). Phosphorus content was determined by Vanadomolybdo-phosphoric acid yellow colour method using blue filter as described by Jackson (1958). Potassium content was determined by flame photometer method as described by Chapman and Pratt (1961).

Research Findings and Discussion

On various major and micro- nutrients content and data recorded their uptake, nutrient status (chemical and biological) and nutrient use efficiency were analyzed and the results and discussion of the experiment are briefly described in this chapter.

The data presented in Table 1 on percentage N content in grain was observed non- significant, difference due to planting dates and maximum N content was noticed (1.3 %) N in late date of sowing. Maximum N content in straw was observed in optimum and late date of sowing practices (0.6 %). In case of nutrient management practices, the maximum nitrogen content in grain was recorded (1.33%) in treatment T_4 (150%NPK STCR based +Zn+S+1%Fe+0.2% B spray). In case of straw (0.65%) was observed in T_2(100%NPK+Zn+S STCR based). The maximum P content in grain (0.21%) and

Table 1: Effect of time of crop establishment and nutrient management practices on major nutrient content in grain and straw rice (%)

Treatments		N		P		K	
		Grain	Straw	Grain	Straw	Grain	Straw
Time of crop establishment							
	Early sowing	1.1	0.4	0.19	0.14	0.37	1.20
	Optimum sowing	1.1	0.6	0.21	0.15	0.35	1.26
	Late sowing	1.3	0.6	0.21	0.14	0.39	1.27
	C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
Nutrient management							
T_1	Control	0.72 ^{c}	0.46 ^{c}	0.17 ^{b}	0.11 ^{c}	0.23 ^{c}	1.11 ^{e}
T_2	100% (NPK+Zn+S)	1.09	0.65 ^{a}	0.21 ^{a}	0.12 ^{b}	0.41 ^{a}	1.17 ^{e}
T_3	100% NPK+Zn+S +1%Fe+0.2%B spray	1.10 ^{a}	0.51	0.20 ^{a}	0.13 ^{b}	0.40 ^{a}	1.19 ^{c}
T_4	150% NPK+Zn+S+1%Fe+0.2% B spray	1.33 ^{a}	0.61 ^{a}	0.21 ^{a}	0.15 ^{a}	0.46 ^{a}	1.27 ^{b}
T_5	100% NPK+ Zn +S +GM @6 t/ha+ FYM @3 t/ha +straw@3 t/ha as mulch +1% Fe + 0.2% B spray	1.26 ^{a}	0.54 ^{a}	0.21 ^{a}	0.14 ^{a}	0.41 ^{a}	1.33 ^{b}
T_6	INM -75% N +100% PK +Zn S+GM @ 5 t/ha +FYM 3 t/ha+ rice straw @ 3 t/ha as mulch+1%Fe+0.2% B spray	1.24 ^{a}	0.51 ^{b}	0.19 ^{b}	0.14 ^{a}	0.38 ^{a}	1.41 ^{a}
T_7	Organic management equivalent to 100%NPK Levels GM, FYM and rice straw	1.28 ^{a}	0.53 ^{b}	0.21 ^{a}	0.13 ^{b}	0.35 ^{b}	1.24 ^{c}
	Nutrient management S.E.±	0.069	0.037	0.009	0.004	0.03	0.06
	Nutrient management C.D. (P=0.05)	0.20	0.146	0.024	0.01	0.08	0.17
	Interaction (T x N)	NS	NS	NS	NS	NS	NS

T x N = Time of crop establishment (T) x Nutrient management (N) NS= Non-significant

straw (0.15%) was found in optimum date of sowing. The nutrient management practices had significant influence on the P content in grain. Significantly higher phosphorus content (0.21%) was found in T_2 (100%NPK+Zn+S STCR based), in case of straw (0.15%) was found in T_4 (150%NPK STCR based +Zn+S+1%Fe+0.2% B spray), The maximum K content in grain (0.39%) and straw (1.27%) was observed in late sowing date of planting. The nutrient management practices had significant increase in K content in both grain and straw. The maximum K content (0.46%) was found in T_4 (150% NPK STCR based +Zn+S+1%Fe+ 0.2% B spray) and straw (1.41%) T_6(INM -75% N+ 100%PK+Zn+S STCR based +GM @ 5 t/ha +FYM 3 t/ ha+ rice straw @ 3 t/ha as mulch+1%Fe+0.2% B spray)

The data presented in Table 2 indicated that time of crop establishment had non-significant difference on zinc content in grain and straw. The maximum zinc content in grain (13.7 ppm) was found in optimum date of planting, maximum zinc content in straw was obtained in early date of planting (30.3 ppm). The nutrient management practices significantly influenced the zinc content of grain. The maximum zinc content (15.7 ppm),was observed in T_5 (100% NPK+Zn+S STCR based +GM @6 t/ha+ FYM @3 t/ha +straw@3 t/ha as mulch +1% Fe + 0.2% B spray). In case of straw maximum Zn content (36.0 ppm) was observed in T_5 (100% NPK+Zn+S STCR based+GM @6 t/ha+ FYM @3t/ha+straw@3 t/ha as mulch+1%Fe+0.2%B spray). In case of iron, the planting methods did not show any significant difference in grain and straw of rice.The maximum iron content (164.1 ppm) in grain was observed in optimum date of sowing. The nutrient management practices had sown significant variation in Fe content in both grain and straw. In case of grain, the maximum Fe content (173.9 ppm) was found in treatment T_4 (150%NPK STCR based +Zn+S+1%Fe+0.2% B spray.) In case of straw, treatment T_7 (Organic management equivalent to 100 per cent NPK Levels STCR based GM, FYM and rice straw) observed significantly higher iron content (158.1 ppm).

The data on total uptake of N,P,K are presented in Table 3 indicated that optimum date of sowing had significant more total uptake of N (67.6 kg ha^{-1}) K (70.8 kg ha^{-1}) and P more total uptake of P (15.5 kg ha^{-1}) at early date of sowing. The nutrient management practices had also significantly influenced the total N uptake by grain and straw and maximum total N uptake was observed in T_4 (150% NPK STCR based+Zn+S+1% Fe+0.2% B spray) (72.70 kg ha^{-1}) and maximum total P

Table 2 : Effect of time of crop establishment and nutrient management practices on micro nutrient content in grain and straw of rice

Treatments		Zn (ppm)		Fe (ppm)	
		Grain	Straw	Grain	Straw
	Time of crop establishment				
	Early sowing	13.6	30.3	163.4	148.3
	Optimum sowing	13.7	30.1	164.1	149.3
	Late sowing	12.8	29.8	163.2	148.2
	C.D. (P=0.05)	NS	NS	NS	NS
Nutrient management					
T_1	Control	11.2 ^{c}	21.0 ^{c}	143.6^{f}	132.9 ^{c}
T_2	100% (NPK+Zn+S)	12.7 ^{b}	31.1^{b}	154.5 ^{e}	137.5 ^{c}
T_3	100% NPK+Zn+S +1%Fe+0.2%B spray	12.2 ^{b}	32.8 ^{b}	164.0^{d}	148.2 ^{b}
T_4	150%NPK+Zn+S+1%Fe+0.2% B spray	15.1 ^{a}	30.6 ^{bc}	173.9 ^{a}	152.2 ^{ab}
T_5	100% NPK+Zn + S +GM @6 t/ha+ FYM @3 t/ha +straw@3 t/ha as mulch +1% Fe + 0.2% B spray	15.7 ^{a}	36.0 ^{a}	172.9 ^{b}	156.3 ^{a}
T_6	INM -75%N +100% PK+Zn S+GM @ 5 t/ha +FYM 3 t/ha+ rice straw @ 3 t/ha as mulch+1%Fe+0.2% B spray	14.6 ^{a}	27.5 ^{c}	167.0 ^{c}	154.9 ^{a}
T_7	Organic management equivalent to 100% NPK Levels GM, FYM and rice straw	12.1 ^{b}	31.7 ^{b}	168.3 ^{c}	158.1 ^{a}
	Nutrient management S.E.±	0.3	0.95	0.51	2.07
	Nutrient management C.D. (P=0.05)	1.2	2.79	1.51	6.06
	Interaction (I xN)	NS	NS	NS	NS

T x N = Time of crop establishment (T) x Nutrient management (N) NS= Non-significant

Table 3: Effect of time of crop establishment and nutrient management practices on major nutrient uptake in grain and straw of rice (kg ha^{-1})

Treatments		N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
		Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Time of crop establishment										
	Early sowing	40.0^{b}	22.6^{a}	62.6^{a}	7.9^{b}	7.6^{a}	15.5^{a}	13.6	53.8^{b}	67.4^{a}
	Optimum sowing	47.1^{a}	20.5^{a}	67.6^{a}	8.2^{a}	7.2^{a}	15.4^{a}	14.2	56.6^{a}	70.8^{a}
	Late sowing	35.4^{c}	16.8^{b}	52.2^{b}	6.4^{c}	5.9^{b}	12.3^{b}	12.1	46.9^{c}	59.0^{b}
	S.E.±	1.0	1.01	1.70	0.25	0.23	0.31	1.32	0.65	0.91
	C.D. (P=0.05)	3.95	3.96	6.7	0.98	0.91	1.22	NS	2.57	3.57
Nutrient management										
T_1	Control	21.2^{d}	13.3^{c}	34.4^{c}	4.9^{c}	4.6^{d}	9.5^{d}	6.7^{c}	38.1^{e}	44.8^{c}
T_2	100% (NPK+Zn+S)	38.5^{c}	25.3^{a}	63.7^{ab}	7.3^{a}	7.7^{a}	15^{ab}	14.9^{a}	61.6^{a}	76.4^{a}
T_3	100% NPK+Zn+S +1%Fe+0.2%B spray	40.4^{bc}	22.0^{a}	62.4^{ab}	7.4^{a}	8.2^{a}	15.6^{a}	14.8^{a}	50.1^{d}	64.9^{b}
T_4	150%NPK+Zn+S+1%Fe+0.2% B spray	50.4^{a}	22.4^{a}	72.7^{a}	8.4^{a}	7.9^{a}	16.3^{a}	17.1^{a}	57.6^{b}	74.8^{a}
T_5	100% NPK+Zn +S +GM @6 t/ha+ FYM @3 t/ha +Straw@3 t/ha as mulch +1% Fe + 0.2% B spray	49.9^{a}	21.6^{a}	71.5^{a}	8.1^{a}	7.5^{a}	15.6^{a}	15.1^{a}	57.4^{b}	72.5^{a}
T_6	INM -75%N +100% PK + Zn S+GM @ 5 t/ha +FYM 3 t/ha+ rice straw @ 3 t/ha as mulch+1%Fe+0.2% B spray	43.6^{b}	17.8^{ab}	61.5^{b}	6.9^{b}	6.5^{b}	13.4^{b}	12.7^{b}	53.9^{c}	66.6^{ab}
T_7	Organic management equivalent to 100% NPK Levels GM, FYM and rice straw	41.9^{b}	17.4^{b}	59.3^{b}	6.9^{b}	6.1^{c}	13^{c}	12.0^{b}	48.2^{d}	60.2^{b}
	Nutrient management SE.±	2.95	1.31	2.85	0.37	0.39	0.60	1.32	2.68	2.82
	Nutrient management C.D. (P=0.05)	8.61	3.84	8.4	1.09	1.16	1.77	2.7	7.8	7.5
	Interaction (TxN)	NS	NS	NS	NS	NS	NS	NS	NS	NS

T x N = Time of crop establishment (T) x Nutrient management (N) NS= Non-significant

Table 4 : Effect of time of crop establishment and nutrient management practices on micro nutrient uptake in grain and straw of rice (g/ha)

Treatments		Zn (g/ha)			Fe (g/ha)		
		Grain	straw	total	Grain	straw	Total
Time of crop establishment							
	Early sowing	48.5^{a}	141.4^{a}	189.9^{a}	574.8^{b}	821.7^{a}	1396.5^{b}
	Optimum sowing	54.3^{a}	152.8^{a}	207.1^{a}	651.2^{a}	793.6^{b}	1444.8^{a}
	Late sowing	42.3^{b}	126.1^{b}	168.3^{b}	511.6^{c}	635.5^{c}	1147.1^{c}
	S.E.±	1.7	5.1	5.85	12.69	22.2	23.51
	C.D.(P=0.05)	6.7	19.8	22.98	49.8	113.0	92.33
Nutrient management							
T_1	Control	36.7^{d}	83.6^{d}	120.3^{c}	419.0^{d}	520.8^{b}	939.8^{c}
T_2	100% (NPK+Zn+S)	45.4^{b}	151.4^{a}	196.8^{b}	545.9^{c}	826.5^{a}	1372.4^{a}
T_3	100% NPK+Zn+S +1%Fe+0.2%B spray	44.4^{bc}	158.7^{a}	203.1^{ab}	602.1^{ab}	832.8^{a}	1434.9^{a}
T_4	150% NPK+Zn+S+1%Fe+0.2% B spray	57.8^{a}	151.4^{a}	209.2^{a}	665.1^{a}	837.2^{a}	1502.3^{a}
T_5	100%NPK+Zn +S +GM @6 t/ha+ FYM @3 t/ha +Straw@3 t/ha as mulch +1% Fe + 0.2% B spray	60.9^{a}	172.7^{a}	233.6^{a}	671.0^{a}	821.5^{a}	1492.5^{a}
T_6	INM -75% N +100% PK + Zn +S+GM @ 5 t/ha +FYM 3 t/ha+ rice straw @ 3 t/ha as mulch+1%Fe+0.2% B spray	50.53^{b}	127.0^{c}	177.5^{b}	580.2^{b}	700.1^{a}	1280.3^{b}
T_7	Organic management equivalent to 100% NPK Levels GM, FYM and rice straw	41.1^{c}	136.1^{b}	177.2^{b}	571.3^{b}	713.2^{a}	1284.5^{b}
	Nutrient management S.E.±	2.43	8.43	9.26	20.51	38.71	39.67
	Nutrient management C.D. (P=0.05)	7.1	24.6	27.05	59.8	195.7	115.81
	Interaction (TxN)	NS	NS	NS	NS	NS	NS

T x N = Time of crop establishment (T) x Nutrient management (N) NS= Non-significant

uptake (16.3 kg ha^{-1}) was observed in T_4 (150% NPK STCR based +Zn+S+1%Fe+0.2% B spray), maximum total K uptake recorded in T_2 (100%NPK+Zn+S STCR based) (76.4 kg ha^{-1}).

The total uptake of Zn data presented in Table 4 indicated that optimum date of sowing rice had significantly more total uptake of Zn (207.1 g ha^{-1}) and Fe (1444.8 g ha^{-1}).

The nutrient management practices had also significantly influenced the Zn uptake with maximum total Zn uptake in T_4 (150%NPK STCR based+Zn+S+1 %Fe+0.2% B spray) (209.2 g ha^{-1}) and maximum total Fe uptake recorded in T_4 (150% NPK STCR based +Zn+S+1%Fe+0.2% B spray) (1502.3 g ha^{-1}).

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